Sampling Episode Report
Holland America Veendam
Sampling Episode 6503

Chapter 4
Results and Discussion

March 2006

4.0 RESULTS AND DISCUSSION

This section presents the data collected during this sampling episode. Section 4.1 presents the analytical results and discussion; Section 4.2 presents interview results for activities that impact wastewater generation; and Section 4.3 presents flow data and analysis. Analytical results for field measurements performed onboard are presented in Appendix A-3. Note that anomalous analytical results were obtained for available and total cyanide; these data have not been excluded from the data set, but the results are presented in and discussed in Section 5.1.1 (in the data quality section of this report) and not in the current section.

4.1 Laboratory Analytical Results and Discussion

4.1.1 Graywater

Table 4-1 presents analytical results for laundry, accommodations, food pulper, and galley wastewaters, which were sampled for one 24-hour period. Only those analytes detected at least once in any of the wastewater samples (i.e., graywater sources, influent to treatment system, or effluent from treatment system) are included in this table. Appendices A-1 and A-2 present results for both detected and nondetected analytes.

Of the 295 analytes tested for in the graywater sources, 67 were detected in these waste streams. Twenty-one of these 67 analytes were also detected at some level in the equipment blank (flagged by an "e" in Table 4-1; see Table 5-2 for equipment blank results), meaning that the sampling equipment may have contributed some or all of these analytes to the samples. EPA will consider the impact of possible contamination from sampling equipment in a future analysis. Thirty-two of these 67 detected analytes were also detected at some level in the potable water used as source water for all graywater systems (flagged by an "s" in Table 4-1; see Table 4-8 for source water results), meaning that the source water may have contributed some or all of these analytes to the samples.

Chart 1 presents the number of analytes detected in each graywater source.

Chart 1. Number of Analytes Detected in Graywater Sources

Analyte Group (a)	Number of Analytes Detected			
	Laundry	Accommodations	Food Pulper	Galley
Pathogen Indicators	0	3	3	3
Classical Pollutants	14	14	15	13
Total and Dissolved Metals	29	33	42	33
Volatile and Semivolatile Organics	1	4	2	2
Total	**44**	**54**	**62**	**51**

(a) See Table 3-3 for information on analyte groups.

Chart 2 presents the number of analytes that were detected in each graywater source at the highest concentration. For example, the highest detected concentrations for two of the pathogen indicators were found in the food pulper wastewater, while the highest detected concentration for the third indicator was found in the accommodations wastewater. Note that a graywater source that has the highest concentration of an analyte will not necessarily contribute the greatest amount of that analyte to the wastewater treatment system. The total amount of an analyte contributed by a particular graywater source also will depend on that source's volume compared to the volumes of the other sources. Flow (and thus volume) information was not able to be collected for all graywater sources (see Table 2-1).

Chart 2. Number of Analytes Detected at Highest Concentration in Graywater

Analyte Group (a)	Number of Analytes Detected in Graywater	Number of Analytes Detected at the Highest Concentration			
		Laundry	Accommodations	Food Pulper	Galley
Pathogen Indicators	3	0	1	2	0
Classical Pollutants	16	1	0	15	0
Total and Dissolved Metals	44	4	8	32	0
Volatile and Semivolatile Organics	4	0	2	2	0
Total	**67**	**5**	**11**	**51**	**0**

(a) See Table 3-3 for information on analyte groups.

Food pulper wastewater contained both the greatest number of detected analytes (62) and the greatest number of analytes detected at the highest concentration (51 out of 67

detected analytes). Food pulper wastewater had the highest concentrations of *E. coli* and enterococci, almost all classical pollutants (including hexane extractable material (HEM) and silica-gel treated hexane extractable material (SGT-HEM), nutrients, and solids), and most metals.

Accommodations wastewater contained a total of 54 analytes and showed the highest concentration among the wastewaters for 11 of the analytes, including fecal coliform, tetrachloroethene, trichloroethene, and 8 metals.

Laundry wastewater contained a total of 44 analytes and showed the highest concentration for 5 analytes, including alkalinity and several dissolved metals. Laundry wastewater was the only graywater source that was analyzed for dioxins and furans because this was the most likely possible source of these analytes; none were detected.

Galley wastewater contained a total of 51 analytes but did not have the highest concentration of any of the analytes among graywater sources. Galley wastewater did, however, show the second highest concentration for several analytes commonly used to measure wastewater strength: al1 3 pathogen indicators, biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), HEM/SGT-HEM, and total suspended solids (TSS). The galley wastewater was sampled before pretreatment (grease trap), which would reduce HEM/SGT-HEM concentrations prior to entering the wastewater treatment system. Galley wastewater was the only graywater source that was analyzed for pesticides because this was the most likely possible source; none were detected.

4.1.2 Influent to Treatment System

Table 4-2 presents analytical results for the influent to the treatment system, which was sampled for five consecutive 24-hour sampling periods. Only those analytes detected at least once in any of the wastewater samples (i.e., graywater sources, influent to treatment system, or effluent from treatment system) are included in this table. Appendices A-1 and A-2 present results for both detected and nondetected analytes.

Pathogen Indicators and Classical Pollutants

All 3 pathogen indicators and all 16 classical pollutants were detected in the influent to treatment samples. One of these 19 analytes (hardness) was also detected at some level in the equipment blank (flagged by an "e" in Table 4-2; see Table 5-2 for equipment blank results), meaning that the sampling equipment may have contributed some or all of this analyte to the samples. EPA will consider the impact of possible contamination from equipment in a future analysis. Eight of these detected analytes were also detected at some level in the potable water used as source water for all graywater and sewage systems (flagged by an "s" in Table 4-2; see Table 4-8 for source water results), meaning that the source water may have contributed some or all of these analytes to the samples.

Wastewater conservation practices used onboard, such as use of vacuum toilets, result in highly concentrated wastewater. Chart 3 compares the influent to the Veendam treatment system to typical domestic wastewater for selected pathogen indicators and classical pollutants. Fecal coliform and enterococci concentrations in the influent to the Veendam treatment system were two or more orders of magnitude greater than in typical untreated domestic wastewater. Key analytes commonly used to assess wastewater strength, such as BOD_5, TSS, and COD, were detected at concentrations two or more times greater than typical domestic wastewater.

Chart 3. Comparison of Influent to Veendam Treatment System to Untreated Domestic Wastewater

Analyte	Influent to Veendam Treatment System	Untreated Domestic Wastewater (a)
Enterococci	10^5 to 10^6 MPN/100 mL	10^2 to 10^3 number/100 mL
Fecal Coliform	10^6 to 10^7 CFU/100 mL	10^4 to 10^5 number/100 mL
Ammonia	60 to 84 mg/L	12 to 50 mg/L
Biochemical Oxygen Demand (BOD_5)	481 to 786 mg/L	110 to 400 mg/L
Chemical Oxygen Demand (COD)	799 to 2,040 mg/L	250 to 1,000 mg/L
Nitrate/Nitrite	ND to 0.07 mg/L	0 mg/L
Oil and Grease	41 to 164 mg/L	50 to 150 mg/L
Total Phosphorus	10 to 20 mg/L	4 to 15 mg/L
Total Suspended Solids (TSS)	473 to 805 mg/L	100 to 350 mg/L

(a) Source: Metcalf & Eddy, *Wastewater Engineering*, Third Edition, 1991.

Total and Dissolved Metals

Of the 36 metal analytes detected in the influent to treatment samples, 27 were detected in every influent to treatment sample (Table 4-2). Twenty of these 36 analytes were detected at some level in the equipment blank (flagged by an "e" in Table 4-2; see Table 5-2 for equipment blank results), meaning that the sampling equipment may have contributed some or all of these analytes to the samples. EPA will consider the impact of possible contamination from equipment in a future analysis. Twenty-four of these detected analytes were also detected at some level in the potable water used as source water for all graywater systems (flagged by an "s" in Table 4-2; see Table 4-8 for source water results), meaning that the source water may have contributed some or all of these analytes to the samples.

The 10 metal analytes detected at the highest concentrations were: total and dissolved calcium, total and dissolved magnesium, total and dissolved iron, total and dissolved sodium, total aluminum, and total zinc. Total and dissolved copper, nickel, selenium, and zinc, and dissolved mercury are priority pollutant metals (designated by EPA in 40 CFR Part 423, Appendix A) that were detected in every influent to treatment sample. Some metals may result from contact with carbon and stainless steel pipes and tanks in the ship.

Volatile and Semivolatile Organics, Pesticides, PCBs

Among the 365 target analytes for volatile and semivolatile organics, pesticides, and polychlorinated biphenyls (PCBs), only 9 were detected in any Veendam influent to treatment samples: 2 semivolatile organics, 2 volatile organics, and 5 PCBs (Table 4-2). Many of these analytes were detected at concentrations close to their detection limits. Neither of the 2 detected semivolatile organics were detected in the equipment blank (see Table 5-2 for equipment blank results; volatile organics and PCBs were not analyzed for in the equipment blank). None of the 4 detected volatile or semivolatile analytes were detected in the source water (see Table 4-8 for source water results; PCBs were not analyzed for in source water).

The two semivolatile organics detected in the influent to treatment were: bis(2-ethylhexyl)phthalate and phenol. Bis(2-ethylhexyl)phthalate is a plasticizer (a chemical added to plastics to make them flexible) and is commonly detected in environmental samples (ATSDR, 2002). Cruise ships use a wide variety of plastic products (e.g., floor tiles, shower curtains, hoses, packaging materials and containers, PVC piping) that may result in the presence of bis(2-ethylhexyl)phthalate in the influent to treatment. Other possible sources include tubing and other plastic materials used by the analytical laboratory.

Phenol is both man-made and produced naturally. It is found in human wastes (urine). It is also found in some foods (smoked summer sausage, fried chicken, mountain cheese, some species of fish). Man-made sources include the use of phenol as a slimicide, as a disinfectant, and in medicinal preparations such as ointments, ear and nose drops, and antiseptic wipes. (ATSDR, 1998) All of these are possible sources for the presence of phenol in cruise ship wastewater.

The two volatile analytes detected in the influent to treatment were tetrachloroethene and trichloroethene. Tetrachloroethene is a solvent used in metal cleaning and dry cleaning (EPA, 2001). The Veendam has a dry cleaning facility, but all tetrachloroethene wastes are collected for shoreside waste disposal. According to the ship's crew, noncontact cooling water (cooling water that does not come into contact with dry cleaning solvent) is routed to the accommodations wastewater system. Tetrachloroethene was detected in accommodations wastewater; however, the average tetrachloroethene concentration in the influent to wastewater treatment was almost 20 times greater than the tetrachloroethene concentration detected in accommodations wastewater. Interviews with the ship's crew did not identify any other sources of tetrachloroethene aboard the Veendam.

Trichloroethene is a solvent used in metal degreasing, metal finishing, paint and ink formulation, and electrical/electronic components (EPA, 2001). The Veendam print shop is equipped with a sink used for hand washing and diluting chemicals. The sink drains to the accommodations wastewater system. Trichloroethene was detected in the accommodations wastewater and in the influent to treatment at similar concentrations.

No pesticides were detected in the influent to the Veendam wastewater treatment system.

Five PCB congeners and co-eluting congener groups were detected in the influent to the wastewater treatment system: PCB-6, PCB-11, PCB-16, PCB-21+PCB-33, and PCB-153+PCB-168. In addition, the laboratory reported values for total dichloro-biphenyls and total PCBs. PCBs were generally detected at very low concentrations, less than one part per billion, just above the reported detection limit. The only exception was PCB-11 (3,3'-dichlorobiphenyl), which was detected at a concentration of twice the detection limit. None of the detected PCBs were among the 12 "toxic" PCBs identified by the World Health Organization. (Note that PCBs were not analyzed for in the source water.)

4.1.3 Influent to the Ultraviolet (UV) Disinfection Part of the Treatment System

Table 4-3 presents pathogen indicator results for the influent to UV disinfection part of the Veendam's wastewater treatment system. Grab samples for pathogen indicator analyses were collected at this sampling point for five consecutive 24-hour sampling periods. Pathogen indicators, which were generally in the millions at the influent to the treatment system (see Table 4-2), were reduced to less than 100 after the bioreactor and membrane filter (i.e., before the UV disinfection step). Data for pathogen indicators in the final effluent (i.e., after the UV disinfection step) are presented in the next section.

4.1.4 Effluent from the Treatment System

Table 4-4 presents analytical results for the effluent from the treatment system, which was sampled for five consecutive 24-hour sampling periods. Only those analytes detected at least once in any of the wastewater samples (i.e., graywater sources, influent to treatment system, or effluent from treatment system) are included in this table. Appendices A-1 and A-2 present results for both detected and nondetected analytes.

Pathogen Indicators and Classical Pollutants

A total of 15 grab samples were collected for analysis of the three pathogen indicators over the five 24-hour sampling periods (results and collection times for each grab sample are presented in Appendix A-1). Pathogen indicators generally were not detected in the effluent from the treatment system; the exceptions to this were 2 grab samples, both on Day 4, with enterococci detected at concentrations close to the detection limit.

Thirteen of the 16 classical pollutants were detected in effluent from treatment system; 3 classical pollutants (HEM, SGT-HEM, and TSS) were not detected in any effluent samples. One of the 13 detected classical analytes–hardness–was also detected at some level in the equipment blank (flagged by an "e" in Table 4-4; see Table 5-2 for equipment blank results), meaning that the sampling equipment may have contributed some or all of this analyte to the samples. EPA will consider the impact of possible contamination from equipment in a future analysis. Eight of these detected analytes were also detected at some level in the potable water used as source water for all graywater and sewage systems (flagged by an "s" in Table 4-4; see Table 4-8 for source water results), meaning that the source water may have contributed some or all of these analytes to the samples.

Chart 4 shows that classical pollutant concentrations in the effluent from the Veendam treatment system are lower than EPA's standards for secondary treatment.

Chart 4. Classical Pollutant Comparison of Effluent from Veendam Treatment System to Secondary Treatment Standards

Classical Pollutant	Average Effluent from Veendam Treatment System	Secondary Treatment Standards (a)
Biochemical Oxygen Demand (BOD_5)	<3.20 mg/L	45 mg/L
Total Suspended Solids (TSS)	ND(5.00) mg/L	45 mg/L

(a) 40 CFR 133.102 Secondary Treatment Regulations, 7-day average.
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
ND - Not detected (number in parentheses is detection limit).

Total and Dissolved Metals

Among the 54 total and dissolved metals analytes tested for, 29 were detected in one or more effluent from treatment samples (Table 4-4). Of these 29 detected metals analytes, 23 were detected in every effluent from treatment sample. Seventeen of the 29 detected metal analytes were also detected at some level in the equipment blank (flagged by an "e" in Table 4-4; see Table 5-2 for equipment blank results), meaning that the sampling equipment may have contributed some or all of these analytes to the samples. EPA will consider the impact of possible contamination from equipment in a future analysis. Twenty-three of these detected analytes were also detected at some level in the potable water used as source water for all graywater systems (flagged by an "s" in Table 4-4; see Table 4-8 for source water results), meaning that the source water may have contributed some or all of these analytes to the samples.

The 10 metal analytes detected at the highest concentrations were total and dissolved calcium, magnesium, iron, sodium, and zinc. Total and dissolved copper, nickel, selenium, and zinc, and dissolved mercury are priority pollutant metals (designated by EPA in 40 CFR Part 423, Appendix A) that were detected in every effluent from treatment sample. Some metals may result from contact with carbon steel and stainless steel pipes and tanks in the ship. There are no EPA secondary treatment standards for metals.

Volatile and Semivolatile Organics, Pesticides, PCBs, Dioxins and Furans

Among the 84 target analytes for volatile and semivolatile organics analyzed, only one–tetrachoroethene–was detected in any Veendam effluent samples (Table 4-4). Tetrachloroethene was detected in the Veendam effluent at an average concentration of 33.4 µg/L. On the Veendam, possible sources of tetrachloroethene include metal cleaning and dry cleaning (see Section 4.1.2).

Pesticides, PCBs, and dioxins and furans were not analyzed for in the effluent from the treatment system.

4.1.5 Wastewater Treatment System Performance: Comparison of Influent to Treatment System and Effluent from Treatment System

The Zenon system successfully removed almost all pathogen indicators (>99%; Table 4-5) and most classical pollutants, metals, and organics (Table 4-6).

Pathogen Indicators and Classical Pollutants

Pathogen indicators were substantially removed by the bioreactor and membrane filter (>96%); any remaining pathogen indicators were generally removed by UV disinfection to levels below detection (overall system efficiency >99%, see Table 4-5). Fecal coliform and *E. coli* were not detected in any of the 15 effluent from treatment samples; enterococci was detected at levels close to the detection limit in 2 of the 15 samples.

The treatment system removed almost all biochemical oxygen demand (BOD_5) (>99%), and most chemical oxygen demand (COD) (97%) and total organic carbon (TOC) (93%) (Table 4-6). The system also removed almost all settleable residue and total suspended solids (TSS) (both >99%). Oils and greases (HEM and SGT-HEM) were removed to levels below detection.

The treatment system reduced ammonia, total Kjeldahl nitrogen (TKN, which measures both ammonia and organic forms of nitrogen), and total phosphorus by approximately 75%, while nitrate/nitrite levels remained relatively unchanged (Table 4-6). Nitrogen is likely taken up by the microorganisms in the bioreactor and removed from the system in the waste biosludge. It is unlikely that nitrogen is removed by nitrification (the mechanism of ammonia biodegradation) as nitrification would have resulted in an increase in nitrate/nitrite concentration, but these levels remained relatively unchanged. Phosphorus also is most likely taken up by the microorganisms in the bioreactor as evidenced by elevated total phosphorus concentrations in the waste biosludge (see Section 4.1.6 and Table 4-7).

Total and Dissolved Metals

The total metals analysis measures both the particulate and dissolved forms of metals, while the dissolved metals analysis measures only the dissolved form. The difference between the total and dissolved metals measurements is the particulate metals concentration. Metals were present in both particulate and dissolved forms in the influent to the treatment system (i.e., the total metals concentrations exceeded the dissolved metals concentrations for most metals analytes) (Table 4-2). In comparison, metals were predominantly present in the dissolved form in the effluent from the treatment system (i.e., the total and dissolved metals concentrations were similar in these samples) (Table 4-4). Furthermore, there were elevated metals concentrations in the screening solids and waste biosludge (see Table 4-7). This means that the treatment system is highly efficient in removing particulate metals, as would be expected for membrane filtration (and as supported by >99% removal of settleable residue and TSS, see Table 4-6). The treatment systems removed dissolved metals with an average efficiency of 37% (Table 4-6).

Volatile and Semivolatile Organics, Pesticides, PCBs, Dioxins and Furans

The treatment system was able to remove most of the volatile and semivolatile organic compounds to levels below detection (Table 4-6). Possible removal mechanisms include biological degradation, adsorption onto screening solids and waste biosludge (see Table 4-7), and/or volatilization.

Pesticides were not detected in the influent to treatment and were not analyzed for in the effluent from treatment. While PCBs were detected in the influent to treatment at low levels, they were not analyzed for in the effluent from treatment; EPA has no data regarding the performance of the Zenon treatment system for removing PCBs. Dioxins and furans were not analyzed for in either the influent to or effluent from the treatment system. Dioxins and furans were analyzed for in laundry wastewater, and none were detected.

4.1.6 Screening Solids, Waste Biosludge, and Incinerator Ash

Table 4-7 presents the results for analytes detected in one-time grab samples of screening solids (from two coarse screens at the beginning of the treatment system), waste biosludge (excess biological mass from the treatment system's bioreactor), and incinerator ash (from incineration of trash, including food solids from the food pulper) collected during the sampling episode. Table 4-7 also shows the average influent to treatment analyte concentrations from Table 4-6 for comparison.

Most of the analytes detected in the screening solids and waste biosludge were also detected in the influent to treatment. For many analytes, concentrations in the screening solids and waste biosludge exceeded those in the influent to treatment, suggesting that these analytes are removed from the system in these waste streams. See Section 4.1.5 for a detailed discussion of wastewater treatment system performance.

4.1.7 Source Water

Potable water is used as source water for all ship operations that generate graywater and sewage (e.g., laundry, galley, food pulper, sinks, showers, and toilets). Potable water is produced onboard and bunkered while in port, with each source providing approximately half of the fresh water requirements for the ship. Twelve total metals, 12 dissolved metals, and 8 classical pollutants were detected in the one-time grab sample of potable water collected during this sampling episode (Table 4-8). None of the analytes detected in the source water exceeded Federal drinking water standards (Table 4-8). Five grab samples of source water were collected for pathogen indicators analysis. No pathogen indicators were detected in these samples.

4.2 Summary of Interviews Regarding Activities that Impact Wastewater Generation

The ship's crew was interviewed to obtain information regarding activities that impact wastewater generation (see Appendix C for detailed reports). The ship's crew provided operational, discharge, and wastewater treatment operating logs corresponding to the period of the sampling episode. These documents are included in the Cruise Ship Rulemaking Record and are available upon request.

4.2.1 Wastewater Generation

Galley

The Veendam has two dining rooms and 24-hour room service. Approximately 4,700 meals (breakfast, lunch, dinner, and snacks) are served daily. The ship's two galleys are equipped with six automatic washing machines (dishwashers, glass washer, pot washers). All six washing machines operate in the evening, and only one dishwasher operates in the morning to handle the small number of meals served at that time. Dishes are washed using Solid Power or Solid Metal Pro (high alkaline solid automatic dishmachine detergents). Both detergents contain 50% caustic soda. The impact of the caustic component of the dishwashing detergent is minimal as the pH of the sampled galley wastewater was 6. The Veendam also uses Rinse Dry, an automatic washing machine rinse aid, which contains an ethyleneoxy/propyleneoxy-derivative nonionic surfactant. Material Safety Data Sheets (MSDS) for these products are included in the Cruise Ship Rulemaking Record and are available upon request.

Laundry

The Veendam laundry is operated 24 hours per day processing approximately five loads of towels and two loads of linens daily; most laundry is washed from approximately 2100 to 0200 each day. On change-over days (i.e., when the ship disembarks passengers and embarks new passengers), more loads of linens are washed. The laundry uses cleaning agents provided by Johnson Diversey; MSDS for these cleaning agents are included in the Cruise Ship

Rulemaking Record and are available upon request. Table 4-9 lists the laundry cleaning agents and their ingredients.

Photo Processing

The Veendam has an onboard photo processing lab. All waste photographic chemicals are collected into drums for disposal onshore. The drums are stored in a sump/containment area to catch any spills. Silver-containing chemical wastes are pretreated by a silver recovery unit, which retains the silver within the filter for eventual recovery. The filtrate is collected into a drum and offloaded for disposal as either hazardous or nonhazardous waste depending on the tested silver content. A laboratory sink is used to rinse equipment such as chemical trays. The sink is physically blocked to prohibit discharges to the accommodations system, and collected rinse waters are pumped to the silver recovery unit. The photo lab has no floor drains to ensure spilled chemicals do not enter the drain system.

Print Shop

The Veendam houses a print shop. The print shop sink is used for hand washing and diluting chemicals for use. The sink drains to the accommodations system. Print shop staff indicated they are careful not to overflow chemicals into the sink when diluting chemicals. The shop has no waste pretreatment facilities and no chemicals are stored in the area. Trichloroethene is a component of print ink and may have contributed to detected concentrations in the accommodations and influent to treatment wastewater samples.

Dry Cleaning

The Veendam has a dry cleaning facility. Solvent wastes from the operation are disposed of onshore as hazardous waste. According to the ship's crew, noncontact cooling water (cooling water that does not come into contact with dry cleaning solvent) drains to the forward holding tank that feeds into the accommodations system. Dry cleaning solvent is stored in plastic drums, and all dry cleaning machinery, piping, and solvent drums are located within a

curbed area designed to contain any spills or leaks and prevent them from entering any floor drains. A sink adjacent to the dry cleaning machine is used for hand washing. Squirt bottles containing stain remover chemicals are stored over the sink.

Chemical Storage

The ship has a discrete area that is used only for chemical storage, primarily laundry cleaning agents, general purpose cleaners, and hand cleaners (no waste is stored in this location). There are no sinks present in the chemical storage area. All chemicals are stored on pallets with no containment. According to the ship's crew, there are no floor drains in the storage area. Additional chemicals may be stored in other locations, such as engine room shops, but the sampling team did not tour these areas.

4.2.2 Pesticide, Fungicide, and Rodenticide Use

The Veendam uses Maxforce bait stations (active ingredient fipronil) to monitor the ship for insects. The bait stations are designed to attract insects and to keep floor wash water out. The monitoring stations are used at all times and are usually placed in galleys, bars, garbage rooms, and some cabins. The Veendam uses two types of spray insecticides: Siegebait (active ingredient hydramethylnon) in cracks and crevices of grout and tiles and Cykick (active ingredient cyfluthrin) in other places. Spray insecticides are used only when an infestation is detected, generally less than once per week. No pesticides were detected in Veendam wastewater samples.

The Veendam does not use fungicides or rodenticides onboard. Traps are set up to catch rodents, and these are inspected routinely. Every six months, the ship hires an outside contractor to conduct an inspection, and the ship is issued a derat certificate.

4.3 Flow Data

Strap-on ultrasonic flow meters were used to collect flow measurements and, in some cases, to control automatic composite sample machines on (1) the outlet from the laundry wastewater holding tank, (2) the influent to the wastewater treatment system, and (3) the effluent from the wastewater treatment system (see Section 2.4 and Figures 2-1 and 2-2). The flow meters were programmed to record the instantaneous flow rate (m^3/min) and total flow (m^3) every five minutes. Appendix B-1 presents all flow measurements from the strap-on flow meters.

In addition, flow data were collected from three of the Veendam's in-line flow meters: (1) on the discharge line from sewage collection tanks, (2) on the discharge line from the graywater storage tanks, and (3) on the effluent from the treatment system (i.e., the overboard discharge line for treated effluent) (see Section 2.4 and Figure 2-2). Combined, the in-line flow meters on the sewage and graywater tank discharges represent the flow into the treatment system. Continuous flow readings from the in-line flow meters are not recorded on the Veendam, so total flow (m^3) was manually recorded 3 to 5 times each day. Appendix B-2 presents the recorded in-line flow meter data.

Note that the times that the in-line flow data were recorded did not always correspond to exactly 24 hours (readings for each sampling day ranged from approximately 22 to 26 hours). Calculations were required to convert these daily flow volumes to the corresponding 24-hour flow volume. First, the total daily flow was calculated as the difference between the total flows recorded at the end of each sampling day. For example, the calculated flow for Day 2 for the effluent from the treatment system was 426 m^3 (300,551 m^3 at 0915 on June 22, 2004 minus 300,125 m^3 at 0654 on June 21, 2004). Second, the calculated total daily flow was prorated to a 24-hour flow volume by multiplying by 24 hours and dividing by the actual time interval of the recorded daily flow measurements. For example, the ratio for the daily flow for Day 2 for the effluent from the treatment system was 0.91 (1,440 minutes divided by 1,581 minutes), resulting in a 24-hour flow volume of 388 m^3. Note that the calculated daily

flow rates from the sewage and graywater in-line flow meters were summed to determine the total daily flow rates to the influent to the treatment system.

Flow data analyses presented in this section are based on only those flow data collected during the sampling episode of June 20 through June 25. Appendix B contains all flow data collected while onboard the Veendam from June 18 through 25.

The total daily volume of laundry wastewater, influent to the treatment system, and effluent from the treatment system for each 24-hour sampling period from both the strap-on and in-line flow meters are presented in Figure 4-1. The Veendam discontinued discharge for part of Day 3 of this sampling episode (while it cruised Glacier Bay National Park) and diverted the wastewater to a holding tank for overboard discharge when outside 12 nm of shore, as can be seen by a dip in the total daily effluent discharge on Day 3. The total daily flow from the laundry, influent, and effluent (excluding Day 3) remained relatively constant over the five-day sampling episode, regardless of whether the ship was in port (Days 1, 4, and 5) or at sea (Days 2 and 3).

The daily flow rates measured by the strap-on flow meter at the influent to treatment are approximately half the influent flow rates calculated from the Veendam's in-line flow meters (on the discharge pipes from the sewage collection and graywater storage tanks) and approximately half the flow rates measured at the effluent from treatment. These data indicate that the quantitative flow data recorded by the strap-on flow meter on the influent to the treatment system are suspect. Therefore, subsequent analyses of flow rates for the influent to and effluent from the treatment system are based on flow measurements from the in-line flow meters. (Analyses of laundry flow rates are based on the strap-on flow meter as there was no in-line flow meter at this location.) Qualitative flow data recorded by the strap-on flow meter on the influent to the treatment system (i.e., fluctuations over time), which controlled collection of flow-weighted composite samples at this sampling point (see Tables 3-1 and 3-2), are believed to be accurate based on a comparison of strap-on and in-line flow meter data.

Daily flow rates and flow per capita are presented in Table 4-10. Per capita flow rates were calculated based on 1,820 people (1,300 passengers and 520 crew) onboard during the sampling episode, as reported by the ship's crew. On average, each person generated approximately 62 gallons of untreated sewage and graywater per day during the sampling episode. This volume included approximately 17 gallons of sewage per day and 45 gallons of graywater per day. Thus, sewage constituted approximately 28% of the total flow to the treatment system and graywater constituted approximately 72%. The average discharge from the treatment system was approximately 58 gallons of treated wastewater per person per day.

Figure 4-2 presents the average effluent from treatment flow for each hour interval over the five consecutive 24-hour sampling periods, calculated from data collected via the strap-on flow meter. The effluent from treatment peaks at around 2200 and fluctuates substantially during the hours from 2200 to around 0500, the period when most passengers are not generating sewage or accommodations wastewater, but when other activities that generate graywater, such as laundry and dishwashing (galley), occur.

Table 4-1

Graywater Analytical Results, Holland America Veendam

Analytical results for each graywater source for analytes detected at least once in wastewater samples during the sampling episode. See Appendices A-1 and A-2 for all analytical results (detected and nondetected). Graywater samples were collected for one 24-hour period; see Section 3.2 for the sample collection methodology. Table 2-1 lists the specific wastewater streams in each graywater source, and Figure 2-1 identifies sampling point locations. Certain food pulper wastewater results were converted from mass to volume units; see Section 3.3. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Laundry (SP-1) (a)	Accommodations (SP-3) (a)	Food Pulper (SP-4) (a)	Galley (SP-5) (a)
Pathogen Indicators						
E. coli (b)	MPN/100 mL		ND(10.0)	520	1,220,000 [N=2]	77,600
Enterococci (b)	MPN/100 mL		ND(10.0)	510	19,600 [N=2]	750
Fecal Coliform (b)	CFU/100 mL		ND(1,000)	7,730,000	79,500 [N=2]	1,300,000
Classical Pollutants						
Alkalinity (s)	mg/L		130	48.0	ND(10.0)	ND(10.0)
Ammonia as Nitrogen (NH3-N) (s)	mg/L		0.360	1.00	29.0	0.460
Biochemical Oxygen Demand (BOD_5)	mg/L		63.6	391	17,300	1,050
Chemical Oxygen Demand (COD)	mg/L		170	541	51,400	1,490
Chloride (s)	mg/L		10.0	38.0	655	42.0
Hardness (e) (s)	mg/L		8.45	54.3	270	56.9
Hexane Extractable Material (HEM)	mg/L		20.0	52.0	5,010	142
Nitrate/Nitrite (NO2-N + NO3-N) (s)	mg/L		0.100	ND(0.0500)	0.220	ND(0.0500)
Settleable Residue	mL/L		ND(0.110)	2.10	900	1.70
Silica Gel Treated HEM (SGT-HEM)	mg/L		ND(6.00)	ND(7.00)	2,240	7.00
Sulfate (s)	mg/L		13.0	17.0	35.0	24.0
Total Dissolved Solids (TDS) (s)	mg/L		222	242	6,050	527

(a) Sampling point location; see Figure 2-1.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with one grab sample for laundry, accommodations, and galley, and two grab samples for food pulper for the 24-hour sampling period. Results for the food pulper grab samples are reported as the average, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
ND - Not detected (number in parentheses is detection limit).

Table 4-1 (Continued)

Analyte	Unit	Priority Pollutant Code	Laundry (SP-1) (a)	Accommodations (SP-3) (a)	Food Pulper (SP-4) (a)	Galley (SP-5) (a)
Total Kjeldahl Nitrogen (TKN) (s)	mg/L		3.00	12.0	166	24.0
Total Organic Carbon (TOC)	mg/L		49.0	144	5,370	250
Total Phosphorus	mg/L		1.00	3.00	46.0	4.00
Total Suspended Solids (TSS)	mg/L		32.0	254	19,800	413
Total and Dissolved Metals						
Aluminum, Total	ug/L		118	745	2,910	201
Antimony, Total	ug/L	P114	ND(5.97)	ND(5.97)	13.6	ND(5.97)
Arsenic, Total	ug/L	P115	ND(2.32)	ND(2.32)	ND(2.32)	ND(2.32)
Barium, Total (e) (s)	ug/L		14.7	89.3	108	83.4
Beryllium, Total	ug/L	P117	ND(0.0540)	ND(0.0540)	ND(0.0540)	ND(0.0540)
Boron, Total (s)	ug/L		ND(3.37)	55.5	166	56.7
Cadmium, Total	ug/L	P118	ND(0.446)	ND(0.446)	1.50	ND(0.446)
Calcium, Total (e) (s)	ug/L		2,520	18,200	71,200	18,200
Chromium, Total	ug/L	P119	ND(1.68)	6.50	16.3	ND(1.68)
Cobalt, Total	ug/L		ND(0.914)	ND(0.914)	2.40	ND(0.914)
Copper, Total (e) (s)	ug/L	P120	258	975	400	88.3
Iron, Total (e) (s)	ug/L		229	5,730	3,010	2,530
Lead, Total (e)	ug/L	P122	8.90	50.2	45.3	10.7
Magnesium, Total (s)	ug/L		525	2,160	22,700	2,790
Manganese, Total (e) (s)	ug/L		6.50	75.0	434	36.3
Mercury, Total (s)	ug/L	P123	ND(0.0170)	0.330	ND(0.0170)	ND(0.0170)
Molybdenum, Total	ug/L		ND(1.50)	ND(1.50)	ND(1.50)	ND(1.50)

(a) Sampling point location; see Figure 2-1.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with one grab sample for laundry, accommodations, and galley, and two grab samples for food pulper for the 24-hour sampling period. Results for the food pulper grab samples are reported as the average, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
ND - Not detected (number in parentheses is detection limit).

Table 4-1 (Continued)

Analyte	Unit	Priority Pollutant Code	Laundry (SP-1) (a)	Accommodations (SP-3) (a)	Food Pulper (SP-4) (a)	Galley (SP-5) (a)
Nickel, Total (s)	ug/L	P124	10.7	29.4	41.6	25.8
Selenium, Total	ug/L	P125	0.960	0.820	16.5	0.770
Silver, Total	ug/L	P126	ND(1.28)	ND(1.28)	2.10	ND(1.28)
Sodium, Total (e) (s)	ug/L		63,700	30,100	376,000	31,800
Thallium, Total (s)	ug/L	P127	ND(0.00900)	ND(0.00900)	0.0100	ND(0.00900)
Tin, Total	ug/L		ND(3.45)	4.50	88.6	4.00
Titanium, Total (e)	ug/L		1.20	6.00	8.80	2.20
Vanadium, Total	ug/L		ND(0.679)	6.20	1.80	ND(0.679)
Yttrium, Total	ug/L		ND(0.222)	ND(0.222)	ND(0.222)	ND(0.222)
Zinc, Total (e) (s)	ug/L	P128	303	1,500	4,210	1,010
Aluminum, Dissolved (e) (s)	ug/L		63.3	268	614	114
Arsenic, Dissolved	ug/L	P115	ND(2.32)	ND(2.32)	5.70	ND(2.32)
Barium, Dissolved (e) (s)	ug/L		3.00	51.4	69.6	57.3
Boron, Dissolved (s)	ug/L		ND(3.37)	61.4	147	56.3
Calcium, Dissolved (e) (s)	ug/L		1,970	16,300	67,100	15,800
Chromium, Dissolved	ug/L	P119	ND(1.68)	ND(1.68)	2.40	ND(1.68)
Cobalt, Dissolved (s)	ug/L		1.50	ND(0.914)	7.60	1.20
Copper, Dissolved (e) (s)	ug/L	P120	182	90.3	17.5	50.9
Iron, Dissolved (e)	ug/L		72.8	3,270	527	1,510
Lead, Dissolved (e)	ug/L	P122	5.90	3.70	4.90	4.00
Magnesium, Dissolved (e) (s)	ug/L		437	1,960	20,900	2,510
Manganese, Dissolved (e) (s)	ug/L		5.80	41.6	8.10	26.5

(a) Sampling point location; see Figure 2-1.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with one grab sample for laundry, accommodations, and galley, and two grab samples for food pulper for the 24-hour sampling period. Results for the food pulper grab samples are reported as the average, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
ND - Not detected (number in parentheses is detection limit).

Table 4-1 (Continued)

Analyte	Unit	Priority Pollutant Code	Laundry (SP-1) (a)	Accommodations (SP-3) (a)	Food Pulper (SP-4) (a)	Galley (SP-5) (a)
Mercury, Dissolved (s)	ug/L	P123	0.180	0.390	0.260	0.270
Nickel, Dissolved (s)	ug/L	P124	7.30	19.6	38.1	22.2
Selenium, Dissolved	ug/L	P125	ND(0.572)	0.670	6.80	0.840
Sodium, Dissolved (e) (s)	ug/L		59,900	29,300	388,000	29,800
Thallium, Dissolved	ug/L	P127	0.0200	ND(0.00900)	0.0800	0.0100
Tin, Dissolved	ug/L		ND(3.45)	ND(3.45)	29.9	6.40
Titanium, Dissolved (e)	ug/L		1.70	0.330	ND(0.253)	0.340
Vanadium, Dissolved	ug/L		1.20	ND(0.679)	0.940	ND(0.679)
Zinc, Dissolved (e) (s)	ug/L	P128	178	635	3,780	599
Volatile and Semivolatile Organics						
Bis(2-ethylhexyl)phthalate	ug/L	P066	29.1	32.6	261	33.2
Phenanthrene	ug/L	P081	ND(10.0)	ND(10.0)	ND(27.9)	ND(10.0)
Phenol	ug/L	P065	ND(10.0)	12.4	32.4	22.2
Tetrachloroethene	ug/L	P085	ND(10.0)	52.3	ND(0.277)	ND(10.0)
Trichloroethene	ug/L	P087	ND(10.0)	20.9	ND(0.277)	ND(10.0)

(a) Sampling point location; see Figure 2-1.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with one grab sample for laundry, accommodations, and galley, and two grab samples for food pulper for the 24-hour sampling period. Results for the food pulper grab samples are reported as the average, followed by an indication of the number of results included in the average (e.g., [N=2]). See Appendix A-1 for all individual grab sample results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
ND - Not detected (number in parentheses is detection limit).

Table 4-2

Influent to Treatment System Analytical Results, Holland America Veendam

Analytical results for the influent to treatment system for analytes detected at least once in wastewater samples during the sampling episode. See Appendices A-1 and A-2 for all analytical results (detected and nondetected). Influent to treatment system samples were collected for five consecutive 24-hour sampling periods; see Section 3.2 for the sample collection methodology. Figure 2-2 identifies sampling point location. Average influent to treatment concentrations determined from the daily results. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Influent to Treatment (SP-6) (a) Day 1	Influent to Treatment (SP-6) (a) Day 2	Influent to Treatment (SP-6) (a) Day 3	Influent to Treatment (SP-6) (a) Day 4	Influent to Treatment (SP-6) (a) Day 5	Average Influent to Treatment (SP-6) (a)
Pathogen Indicators								
E. coli (b)	MPN/100 mL		>1,370,000 [N=4]	>8,650,000 [N=3]	8,010,000 [N=2]	6,290,000 [N=3]	5,870,000 [N=3]	>6,040,000
Enterococci (b)	MPN/100 mL		>750,000 [N=4]	>1,110,000 [N=3]	4,950,000 [N=2]	1,340,000 [N=3]	2,910,000 [N=3]	>2,210,000
Fecal Coliform (b)	CFU/100 mL		8,390,000 [N=4]	10,900,000 [N=3]	71,000,000 [N=2]	68,300,000 [N=3]	6,970,000 [N=3]	33,100,000
Classical Pollutants								
Alkalinity (s)	mg/L		311	435	323	376	368	363
Ammonia as Nitrogen (NH3-N) (s)	mg/L		60.0	84.0	63.0	80.0	68.0	71.0
Biochemical Oxygen Demand (BOD_5)	mg/L		504	786	576	481	537	577
Chemical Oxygen Demand (COD)	mg/L		799	1,960	1,300	2,040	1,280	1,480
Chloride (s)	mg/L		72.0	88.0	75.0	84.0	76.0	79.0
Hardness (e) (s)	mg/L		47.6	78.3	68.5	74.6	71.0	68.0
Hexane Extractable Material (HEM) (c)	mg/L		41.0	79.0	129	164	88.0	100
Nitrate/Nitrite (NO2-N + NO3-N) (s)	mg/L		0.0600	0.0700	ND(0.0500)	ND(0.0500)	ND(0.0500)	<0.0560

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with a minimum of two grab samples and a maximum of four grab samples per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(c) Two sample volumes of HEM and SGT-HEM were inadvertently analyzed for Days 3 and 4. Reported results for these analyses for these days are averaged results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Average result includes at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).

Table 4-2 (Continued)

Analyte	Unit	Priority Pollutant Code	Influent to Treatment (SP-6) (a) Day 1	Influent to Treatment (SP-6) (a) Day 2	Influent to Treatment (SP-6) (a) Day 3	Influent to Treatment (SP-6) (a) Day 4	Influent to Treatment (SP-6) (a) Day 5	Average Influent to Treatment (SP-6) (a)
Settleable Residue	ML/L		40.0	82.0	22.0	66.0	69.0	55.8
Silica Gel Treated HEM (SGT-HEM) (c)	mg/L		6.10	7.00	34.5	14.5	10.0	14.4
Sulfate (s)	mg/L		26.0	33.0	30.0	32.0	28.0	29.8
Total Dissolved Solids (TDS) (s)	mg/L		453	492	510	435	432	464
Total Kjeldahl Nitrogen (TKN) (s)	mg/L		91.0	141	103	86.0	103	105
Total Organic Carbon (TOC)	mg/L		182	187	192	235	195	198
Total Phosphorus	mg/L		10.0	13.0	13.0	19.0	20.0	15.0
Total Suspended Solids (TSS)	mg/L		473	805	630	655	710	655
Total and Dissolved Metals								
Aluminum, Total	ug/L		419	597	508	597	532	531
Antimony, Total	ug/L	P114	ND(5.97)	ND(5.97)	ND(5.97)	ND(5.97)	ND(5.97)	ND(5.97)
Arsenic, Total	ug/L	P115	ND(2.32)	2.60	ND(2.32)	ND(2.32)	2.50	<2.41
Barium, Total (e) (s)	ug/L		59.1	71.0	64.6	65.2	60.6	64.1
Beryllium, Total	ug/L	P117	ND(0.0540)	ND(0.0540)	ND(0.0540)	ND(0.0540)	ND(0.0540)	ND(0.0540)
Boron, Total (s)	ug/L		62.1	69.3	77.9	72.1	59.0	68.1
Cadmium, Total	ug/L	P118	ND(0.446)	0.460	ND(0.446)	ND(0.446)	ND(0.446)	< 0.449
Calcium, Total (e) (s)	ug/L		13,300	23,200	20,900	22,600	20,800	20,200
Chromium, Total	ug/L	P119	ND(1.68)	3.70	2.00	3.70	4.00	<3.02
Cobalt, Total	ug/L		ND(0.914)	ND(0.914)	ND(0.914)	ND(0.914)	ND(0.914)	ND(0.914)
Copper, Total (e) (s)	ug/L	P120	185	314	285	263	184	246

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with a minimum of two grab samples and a maximum of four grab samples per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(c) Two sample volumes of HEM and SGT-HEM were inadvertently analyzed for Days 3 and 4. Reported results for these analyses for these days are averaged results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Average result includes at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).

Table 4-2 (Continued)

Analyte	Unit	Priority Pollutant Code	Influent to Treatment (SP-6) (a) Day 1	Influent to Treatment (SP-6) (a) Day 2	Influent to Treatment (SP-6) (a) Day 3	Influent to Treatment (SP-6) (a) Day 4	Influent to Treatment (SP-6) (a) Day 5	Average Influent to Treatment (SP-6) (a)
Iron, Total (e) (s)	ug/L		1,590	1,590	1,740	1,700	1,430	1,610
Lead, Total (e)	ug/L	P122	14.8	9.20	4.90	3.90	ND(3.08)	<7.18
Magnesium, Total (s)	ug/L		3,500	4,940	3,970	4,420	4,630	4,290
Manganese, Total (e) (s)	ug/L		48.3	67.7	56.5	61.8	61.1	59.1
Mercury, Total (s)	ug/L	P123	0.360	0.500	0.520	ND(0.0170)	0.720	<0.423
Molybdenum, Total	ug/L		ND(1.50)	ND(1.50)	ND(1.50)	ND(1.50)	ND(1.50)	ND(1.50)
Nickel, Total (s)	ug/L	P124	35.7	33.0	24.2	21.6	21.9	27.3
Selenium, Total	ug/L	P125	1.10	1.50	1.00	1.30	1.40	1.26
Silver, Total	ug/L	P126	ND(1.28)	1.70	ND(1.28)	1.30	3.90	<1.89
Sodium, Total (e) (s)	ug/L		76,000	91,900	80,200	74,400	68,200	78,100
Thallium, Total (s)	ug/L	P127	ND(0.00900)	ND(0.00900)	ND(0.00900)	ND(0.00900)	ND(0.00900)	ND(0.000900)
Tin, Total	ug/L		ND(3.45)	ND(3.45)	ND(3.45)	6.80	4.40	<4.31
Titanium, Total (e)	ug/L		1.90	2.80	2.10	2.40	3.40	2.52
Vanadium, Total	ug/L		ND(0.679)	ND(0.679)	ND(0.679)	ND(0.679)	ND(0.679)	ND(0.679)
Yttrium, Total	ug/L		ND(0.222)	ND(0.222)	ND(0.222)	ND(0.222)	ND(0.222)	ND(0.222)
Zinc, Total (e) (s)	ug/L	P128	1,300	1,080	841	797	719	947
Aluminum, Dissolved (e) (s)	ug/L		107	31.0	51.4	238	65.3	98.5
Arsenic, Dissolved	ug/L	P115	ND(2.32)	ND(2.32)	ND(2.32)	ND(2.32)	ND(2.32)	ND(2.32)
Barium, Dissolved (e) (s)	ug/L		19.8	14.5	18.1	34.1	15.7	20.4
Boron, Dissolved (s)	ug/L		63.2	68.8	71.2	72.8	62.3	67.7

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with a minimum of two grab samples and a maximum of four grab samples per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(c) Two sample volumes of HEM and SGT-HEM were inadvertently analyzed for Days 3 and 4. Reported results for these analyses for these days are averaged results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Average result includes at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).

Table 4-2 (Continued)

Analyte	Unit	Priority Pollutant Code	Influent to Treatment (SP-6) (a) Day 1	Influent to Treatment (SP-6) (a) Day 2	Influent to Treatment (SP-6) (a) Day 3	Influent to Treatment (SP-6) (a) Day 4	Influent to Treatment (SP-6) (a) Day 5	Average Influent to Treatment (SP-6) (a)
Calcium, Dissolved (e) (s)	ug/L		9,600	12,700	13,900	17,500	13,200	13,400
Chromium, Dissolved	ug/L	P119	ND(1.68)	ND(1.68)	ND(1.68)	ND(1.68)	ND(1.68)	ND(1.68)
Cobalt, Dissolved (s)	ug/L		4.00	4.10	3.00	2.10	4.20	3.48
Copper, Dissolved (e) (s)	ug/L	P120	44.5	37.1	42.8	136	34.4	59.0
Iron, Dissolved (e)	ug/L		624	395	512	921	419	574
Lead, Dissolved (e)	ug/L	P122	3.10	ND(3.08)	ND(3.08)	ND(3.08)	ND(3.08)	<3.08
Magnesium, Dissolved (e) (s)	ug/L		2,780	3,680	3,020	3,900	3,480	3,370
Manganese, Dissolved (e) (s)	ug/L		18.1	20.8	17.2	37.6	20.7	22.9
Mercury, Dissolved (s)	ug/L	P123	0.350	0.320	0.330	0.420	0.380	0.360
Nickel, Dissolved (s)	ug/L	P124	33.3	26.3	20.7	17.2	16.0	22.7
Selenium, Dissolved	ug/L	P125	0.870	1.20	0.840	1.00	1.00	0.982
Sodium, Dissolved (e) (s)	ug/L		73,900	86,000	72,900	75,200	65,400	74,700
Thallium, Dissolved	ug/L	P127	ND(0.00900)	ND(0.00900)	ND(0.00900)	ND(0.00900)	ND(0.00900)	ND(0.00900)
Tin, Dissolved	ug/L		ND(3.45)	ND(3.45)	ND(3.45)	ND(3.45)	ND(3.45)	ND(3.45)
Titanium, Dissolved (e)	ug/L		ND(0.253)	ND(0.253)	ND(0.253)	0.560	ND(0.253)	<0.314
Vanadium, Dissolved	ug/L		ND(0.679)	ND(0.679)	ND(0.679)	ND(0.679)	ND(0.679)	ND(0.679)
Zinc, Dissolved (e) (s)	ug/L	P128	634	288	199	357	111	318
Volatile and Semivolatile Organics								
Bis(2-ethylhexyl)phthalate	ug/L	P066	10.1	15.3	20.3	24.0	ND(10.0)	<15.9
Phenanthrene	ug/L	P081	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with a minimum of two grab samples and a maximum of four grab samples per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(c) Two sample volumes of HEM and SGT-HEM were inadvertently analyzed for Days 3 and 4. Reported results for these analyses for these days are averaged results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Average result includes at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).

Table 4-2 (Continued)

Analyte	Unit	Priority Pollutant Code	Influent to Treatment (SP-6) (a) Day 1	Influent to Treatment (SP-6) (a) Day 2	Influent to Treatment (SP-6) (a) Day 3	Influent to Treatment (SP-6) (a) Day 4	Influent to Treatment (SP-6) (a) Day 5	Average Influent to Treatment (SP-6) (a)
Phenol	ug/L	P065	13.9	15.0	13.4	ND(10.0)	25.1	<15.5
Tetrachloroethene	ug/L	P085	443	274	147	1,360	2,740	993
Trichloroethene	ug/L	P087	32.2	20.1	24.4	66.9	58.0	40.3
Polychlorinated Biphenyls								
PCB-6	pg/L		60.0	NC	NC	NC	NC	
PCB-11	pg/L		496	NC	NC	NC	NC	
PCB-16	pg/L		124	NC	NC	NC	NC	
PCB-21+PCB-33	pg/L		230	NC	NC	NC	NC	
PCB-153+PCB-168	pg/L		610	NC	NC	NC	NC	
Total Dichloro Biphenyls	pg/L		556	NC	NC	NC	NC	
Total Hexachloro Biphenyls	pg/L		610	NC	NC	NC	NC	
Total Trichloro Biphenyls	pg/L		354	NC	NC	NC	NC	
Total PCBs	pg/L		1520	NC	NC	NC	NC	

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with a minimum of two grab samples and a maximum of four grab samples per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(c) Two sample volumes of HEM and SGT-HEM were inadvertently analyzed for Days 3 and 4. Reported results for these analyses for these days are averaged results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Average result includes at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D).

Table 4-3

Influent to UV Disinfection Analytical Results, Holland America Veendam

Analytical results for the influent to UV disinfection part of the wastewater treatment system. Influent to UV disinfection samples were collected for five consecutive 24-hour sampling periods; see Section 3.2 for the sample collection methodology. Figure 2-2 identifies sampling point location. Average influent to UV concentrations determined from the daily results.

Analyte	Unit	Influent to UV (SP-8) (a) Day 1	Influent to UV (SP-8) (a) Day 2	Influent to UV (SP-8) (a) Day 3	Influent to UV (SP-8) (a) Day 4	Influent to UV (SP-8) (a) Day 5	Average Influent to UV (SP-8) (a)
Pathogen Indicators							
E. coli (b)	MPN/100 mL	97.9 [N=4]	7.33 [N=3]	< 1.50 [N=2]	< 1.02 [N=3]	43.2 [N=3]	<30.2
Enterococci (b)	MPN/100 mL	37.0 [N=4]	9.25 [N=2]	2.50 [N=2]	54.2 [N=3]	54.2 [N=3]	31.4
Fecal Coliform (b)	CFU/100 mL	100 [N=4]	12.0 [N=3]	6.00 [N=2]	< 3.80 [N=3]	< 13.1 [N=3]	<27.0

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with a minimum of two grab samples and a maximum of four grab samples collected per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-4

Effluent from Treatment System Analytical Results, Holland America Veendam

Analytical results for the effluent from treatment system for analytes detected at least once in wastewater samples during the sampling episode. See Appendices A-1 and A-2 for all analytical results (detected and nondetected). Effluent from treatment system samples were collected for five consecutive 24-hour sampling periods; see Section 3.2 for the sample collection methodology. Figure 2-2 identifies sampling point location. Average effluent from treatment concentrations determined from the daily results. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Effluent from Treatment (SP-9) (a) Day 1	Effluent from Treatment (SP-9) (a) Day 2	Effluent from Treatment (SP-9) (a) Day 3	Effluent from Treatment (SP-9) (a) Day 4	Effluent from Treatment (SP-9) (a) Day 5	Average Effluent from Treatment (SP-9) (a)
Pathogen Indicators								
E. coli (b)	MPN/100 mL		ND(1.00)[N=4]	ND(1.00)[N=3]	ND(1.00)[N=2]	ND(1.00)[N=3]	ND(1.00)[N=3]	ND(1.00)
Enterococci (b)	MPN/100 mL		ND(1.00)[N=3]	ND(1.00)[N=3]	ND(1.00)[N=2]	< 1.68 [N=3]	ND(1.00)[N=3]	<1.14
Fecal Coliform (b)	CFU/100 mL		ND(1.00)[N=4]	ND(1.00)[N=3]	ND(1.00)[N=2]	ND(1.00)[N=3]	ND(1.00)[N=3]	ND(1.00)
Classical Pollutants								
Alkalinity (s)	mg/L		222	265	252	244	242	245
Ammonia as Nitrogen (NH3-N) (s)	mg/L		11.0	12.0	12.0	28.0	29.0	18.4
Biochemical Oxygen Demand (BOD_5)	mg/L		3.64	5.95	ND(2.00)	2.05	2.37	<3.20
Chemical Oxygen Demand (COD)	mg/L		33.5	37.0	34.0	38.0	42.5	37.0
Chloride (s)	mg/L		61.0	67.0	70.0	68.0	64.0	66.0
Hardness (e) (s)	mg/L		24.2	36.0	40.6	45.1	45.3	38.2
Hexane Extractable Material (HEM) (c)	mg/L		ND(5.00)	ND(6.00)	ND(5.00)	ND(5.50)	ND(6.00)	ND(5.50)
Nitrate/Nitrite (NO2-N + NO3-N) (s)	mg/L		ND(0.0500)	0.120	0.110	ND(0.0500)	ND(0.0500)	<0.0760
Settleable Residue	mg/L		ND(0.100)	ND(0.130)	ND(0.110)	ND(0.110)	< 0.555	<0.201

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with a minimum of two grab samples and a maximum of four grab samples per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(c) Two sample volumes of HEM and SGT-HEM were inadvertently analyzed for Days 3, 4, and 5. Reported results for these analyses for these days are averaged results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-4 (Continued)

Analyte	Unit	Priority Pollutant Code	Effluent from Treatment (SP-9) (a) Day 1	Effluent from Treatment (SP-9) (a) Day 2	Effluent from Treatment (SP-9) (a) Day 3	Effluent from Treatment (SP-9) (a) Day 4	Effluent from Treatment (SP-9) (a) Day 5	Average Effluent from Treatment (SP-9) (a)
Silica Gel Treated HEM (SGT-HEM) (c)	mg/L		ND(5.00)	ND(6.00)	ND(5.00)	ND(5.50)	ND(6.00)	ND(5.50)
Sulfate (s)	mg/L		ND(3.00)	4.00	9.00	18.0	15.0	<9.80
Total Dissolved Solids (TDS) (s)	mg/L		324	386	354	318	309	338
Total Kjeldahl Nitrogen (TKN) (s)	mg/L		34.0	13.0	22.0	29.0	28.5	25.3
Total Organic Carbon (TOC)	mg/L		12.5	16.0	14.0	15.0	13.0	14.1
Total Phosphorus	mg/L		0.190	0.120	0.130	9.00	7.50	3.39
Total Suspended Solids (TSS)	mg/L		ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)	ND(5.00)
Total and Dissolved Metals								
Aluminum, Total	ug/L		33.1	43.6	46.2	40.3	40.0	40.6
Antimony, Total	ug/L	P114	ND(5.97)	ND(5.97)	ND(5.97)	ND(5.97)	ND(5.97)	ND(5.97)
Arsenic, Total	ug/L	P115	ND(2.32)	ND(2.32)	ND(2.32)	ND(2.32)	ND(2.32)	ND(2.32)
Barium, Total (e) (s)	ug/L		16.0	24.7	25.8	18.6	14.6	19.9
Beryllium, Total	ug/L	P117	ND(0.0540)	ND(0.0540)	ND(0.0540)	ND(0.0540)	ND(0.0540)	ND(0.0540)
Boron, Total (s)	ug/L		ND(3.37)	ND(3.37)	ND(3.37)	ND(3.37)	ND(3.37)	ND(3.37)
Cadmium, Total	ug/L	P118	ND(0.446)	ND(0.446)	ND(0.446)	ND(0.446)	ND(0.446)	ND(0.446)
Calcium, Total (e) (s)	ug/L		7,240	11,300	13,000	14,200	14,100	12,000
Chromium, Total	ug/L	P119	ND(1.68)	ND(1.68)	ND(1.68)	ND(1.68)	ND(1.68)	ND(1.68)
Cobalt, Total	ug/L		ND(0.914)	ND(0.914)	ND(0.914)	ND(0.914)	ND(0.914)	ND(0.914)
Copper, Total (e) (s)	ug/L	P120	10.6	11.8	8.70	6.90	6.90	8.97

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with a minimum of two grab samples and a maximum of four grab samples per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(c) Two sample volumes of HEM and SGT-HEM were inadvertently analyzed for Days 3, 4, and 5. Reported results for these analyses for these days are averaged results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-4 (Continued)

Analyte	Unit	Priority Pollutant Code	Effluent from Treatment (SP-9) (a) Day 1	Effluent from Treatment (SP-9) (a) Day 2	Effluent from Treatment (SP-9) (a) Day 3	Effluent from Treatment (SP-9) (a) Day 4	Effluent from Treatment (SP-9) (a) Day 5	Average Effluent from Treatment (SP-9) (a)
Iron, Total (e) (s)	ug/L		376	296	367	283	171	298
Lead, Total (e)	ug/L	P122	ND(3.08)	ND(3.08)	ND(3.08)	ND(3.08)	ND(3.08)	ND(3.08)
Magnesium, Total (s)	ug/L		1,490	1,900	2,000	2,350	2,460	2,040
Manganese, Total (e) (s)	ug/L		12.2	16.2	18.1	18.4	15.8	16.1
Mercury, Total (s)	ug/L	P123	ND(0.0170)	ND(0.0170)	< 0.164	0.320	0.320	<0.168
Molybdenum, Total	ug/L		ND(1.50)	ND(1.50)	ND(1.50)	ND(1.50)	ND(1.50)	ND(1.50)
Nickel, Total (s)	ug/L	P124	23.8	18.3	14.6	11.8	8.00	15.3
Selenium, Total	ug/L	P125	< 0.586	0.840	0.680	0.830	0.970	<0.781
Silver, Total	ug/L	P126	ND(1.28)	ND(1.28)	ND(1.28)	ND(1.28)	ND(1.28)	ND(1.28)
Sodium, Total (e) (s)	ug/L		93,600	107,000	89,100	74,600	69,600	86,800
Thallium, Total (s)	ug/L	P127	ND(0.00900)	0.0100	ND(0.00900)	ND(0.00900)	ND(0.00900)	<0.00920
Tin, Total	ug/L		ND(3.45)	ND(3.45)	ND(3.45)	ND(3.45)	ND(3.45)	ND(3.45)
Titanium, Total (e)	ug/L		ND(0.253)	ND(0.253)	ND(0.253)	ND(0.253)	ND(0.253)	ND(0.253)
Vanadium, Total	ug/L		ND(0.679)	ND(0.679)	ND(0.679)	ND(0.679)	ND(0.679)	ND(0.679)
Yttrium, Total	ug/L		ND(0.222)	ND(0.222)	ND(0.222)	ND(0.222)	ND(0.222)	ND(0.222)
Zinc, Total (e) (s)	ug/L	P128	549	562	333	196	162	360
Aluminum, Dissolved (e) (s)	ug/L		34.7	41.9	37.2	38.6	34.6	37.4
Arsenic, Dissolved	ug/L	P115	ND(2.32)	ND(2.32)	ND(2.32)	ND(2.32)	ND(2.32)	ND(2.32)
Barium, Dissolved (e) (s)	ug/L		15.6	24.5	25.8	18.2	14.5	19.7
Boron, Dissolved (s)	ug/L		ND(3.37)	ND(3.37)	ND(3.37)	ND(3.37)	20.7	<6.84

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with a minimum of two grab samples and a maximum of four grab samples per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(c) Two sample volumes of HEM and SGT-HEM were inadvertently analyzed for Days 3, 4, and 5. Reported results for these analyses for these days are averaged results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-4 (Continued)

Analyte	Unit	Priority Pollutant Code	Effluent from Treatment (SP-9) (a) Day 1	Effluent from Treatment (SP-9) (a) Day 2	Effluent from Treatment (SP-9) (a) Day 3	Effluent from Treatment (SP-9) (a) Day 4	Effluent from Treatment (SP-9) (a) Day 5	Average Effluent from Treatment (SP-9) (a)
Calcium, Dissolved (e) (s)	ug/L		7,090	11,200	13,000	14,000	14,000	11,800
Chromium, Dissolved	ug/L	P119	ND(1.68)	ND(1.68)	ND(1.68)	ND(1.68)	ND(1.68)	ND(1.68)
Cobalt, Dissolved (s)	ug/L		< 0.957	ND(0.914)	ND(0.914)	ND(0.914)	1.50	<1.04
Copper, Dissolved (e) (s)	ug/L	P120	8.70	11.0	7.20	5.60	7.50	8.00
Iron, Dissolved (e)	ug/L		356	296	357	266	152	285
Lead, Dissolved (e)	ug/L	P122	ND(3.08)	ND(3.08)	ND(3.08)	ND(3.08)	ND(3.08)	ND(3.08)
Magnesium, Dissolved (e) (s)	ug/L		1,460	1,880	2,020	2,320	2,440	2,020
Manganese, Dissolved (e) (s)	ug/L		13.4	16.1	19.3	19.4	18.3	17.3
Mercury, Dissolved (s)	ug/L	P123	0.270	0.270	0.330	0.360	0.390	0.324
Nickel, Dissolved (s)	ug/L	P124	23.5	18.8	14.9	11.7	8.40	15.5
Selenium, Dissolved	ug/L	P125	< 0.606	0.720	0.805	0.700	0.900	<0.746
Sodium, Dissolved (e) (s)	ug/L		91,200	105,000	89,000	73,500	69,700	85,700
Thallium, Dissolved	ug/L	P127	ND(0.00900)	ND(0.00900)	ND(0.00900)	ND(0.00900)	ND(0.00900)	ND(0.00900)
Tin, Dissolved	ug/L		ND(3.45)	ND(3.45)	ND(3.45)	ND(3.45)	ND(3.45)	ND(3.45)
Titanium, Dissolved (e)	ug/L		< 0.317	ND(0.253)	< 0.297	ND(0.253)	ND(0.253)	<0.274
Vanadium, Dissolved	ug/L		ND(0.679)	0.760	ND(0.679)	ND(0.679)	ND(0.679)	<0.695
Zinc, Dissolved (e) (s)	ug/L	P128	534	553	323	191	164	353

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with a minimum of two grab samples and a maximum of four grab samples per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(c) Two sample volumes of HEM and SGT-HEM were inadvertently analyzed for Days 3, 4, and 5. Reported results for these analyses for these days are averaged results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-4 (Continued)

Analyte	Unit	Priority Pollutant Code	Effluent from Treatment (SP-9) (a) Day 1	Effluent from Treatment (SP-9) (a) Day 2	Effluent from Treatment (SP-9) (a) Day 3	Effluent from Treatment (SP-9) (a) Day 4	Effluent from Treatment (SP-9) (a) Day 5	Average Effluent from Treatment (SP-9) (a)
Volatile and Semivolatile Organics								
Bis(2-ethylhexyl)phthalate	ug/L	P066	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
Phenanthrene	ug/L	P081	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
Phenol	ug/L	P065	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)
Tetrachloroethene	ug/L	P085	10.4	37.4	47.7	26.5	45.1	33.4
Trichloroethene	ug/L	P087	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)	ND(10.0)

(a) Sampling point location; see Figure 2-2.
(b) Samples for pathogen indicator analyses were collected as grab samples for individual analysis, with a minimum of two grab samples and a maximum of four grab samples per 24-hour sampling period. Results are reported as an average for each 24-hour sampling period, followed by an indication of the number of results included in the average (e.g., [N=3]). See Appendix A-1 for all individual grab sample results.
(c) Two sample volumes of HEM and SGT-HEM were inadvertently analyzed for Days 3, 4, and 5. Reported results for these analyses for these days are averaged results.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-5

Wastewater Treatment System: Performance Data for Pathogen Indicators, Holland America Veendam

Pathogen indicators performance data for the Veendam's Zenon wastewater treatment system. Average analyte concentrations were determined from the daily results presented in Tables 4-2 through 4-4. Percent removals were calculated using the average influent to and effluent from treatment analyte concentrations.

Analyte	Unit	Average Influent to Treatment Concentration (SP-6) (a)	Average Influent to UV Disinfection Concentration (SP-8) (a)	Average Effluent from Treatment Concentration (SP-10) (a)	Percent Removal
Pathogen Indicators					
E. coli	MPN/100 mL	> 6,040,000	<30.2	ND(1.00)	> 99
Enterococci	MPN/100 mL	> 2,210,000	31.4	<1.14	> 99
Fecal Coliform	CFU/100 mL	33,100,000	<27.0	ND(1.00)	> 99

(a) Sampling point location; see Figure 2-2.
ND - Not detected (number in parenthesis is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - In an average, average result includes at least one result flagged by the laboratory as ">" because the sample was not diluted sufficiently (see Appendix D). In a removal, indicates a minimum level of removal.

Table 4-6

Wastewater Treatment System: Performance Data for Analytes Other Than Pathogen Indicators, Holland America Veendam

Performance data for the Veendam's Zenon wastewater treatment system for analytes other than pathogen indicators detected in either the influent to or effluent from treatment. Range and average analyte concentrations were determined from the daily results presented in Tables 4-2 and 4-4. Percent removals were calculated using the average influent and effluent analyte concentrations. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Average Influent to Treatment Concentration (SP-6) (a)	Influent to Treatment Concentration Range (SP-6) (a)	Average Effluent from Treatment Concentration (SP-9) (a)	Effluent from Treatment Concentration Range (SP-9) (a)	Percent Removal
Classical Pollutants							
Alkalinity (s)	mg/L		363	311 - 435	245	222 - 265	32
Ammonia As Nitrogen (NH3-N) (s)	mg/L		71.0	60.0 - 84.0	18.4	11.0 - 29.0	74
Biochemical Oxygen Demand (BOD_5)	mg/L		577	481 - 786	<3.20	ND(2.00) - 5.95	> 99
Chemical Oxygen Demand (COD)	mg/L		1,480	799 - 2,040	37.0	33.5 - 42.5	97
Chloride (s)	mg/L		79.0	72.0 - 88.0	66.0	61.0 - 70.0	16
Hardness (e) (s)	mg/L		68.0	47.6 - 78.3	38.2	24.2 - 45.3	44
Hexane Extractable Material (HEM)	mg/L		100	41.0 - 164	ND(5.50)	ND(5.00) - ND(6.00)	> 95
Nitrate/Nitrite (NO2-N + NO3-N) (s)	mg/L		<0.0560	ND(0.0500) - 0.0700	<0.0760	ND(0.0500) - 0.120	NC
Settleable Residue	mL/L		55.8	22.0 - 82.0	<0.201	ND(0.100) - <0.555	> 99
Silica Gel Treated HEM (SGT-HEM)	mg/L		14.4	6.10 - 34.5	ND(5.50)	ND(5.00) - ND(6.00)	> 62
Sulfate (s)	mg/L		29.8	26.0 - 33.0	<9.80	ND(3.00) - 18.0	67
Total Dissolved Solids (TDS) (s)	mg/L		464	432 - 510	338	309 - 386	27
Total Kjeldahl Nitrogen (TKN) (s)	mg/L		105	86.0 - 141	25.3	13.0 - 34.0	76
Total Organic Carbon (TOC)	mg/L		198	182 - 235	14.1	12.5 - 16.0	93

(a) Sampling point location; see Figure 2-2.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
NC - Percent removal not calculated because the effluent concentration was greater than the influent concentration, or the analyte was not detected in the influent sample.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Indicates a minimum level of removal.

Table 4-6 (Continued)

Analyte	Unit	Priority Pollutant Code	Average Influent to Treatment Concentration (SP-6) (a)	Influent to Treatment Concentration Range (SP-6) (a)	Average Effluent from Treatment Concentration (SP-9) (a)	Effluent from Treatment Concentration Range (SP-9) (a)	Percent Removal
Total Phosphorus	mg/L		15.0	10.0 - 20.0	3.39	0.120 - 9.00	77
Total Suspended Solids (TSS)	mg/L		655	473 - 805	ND(5.00)	ND(5.00)	> 99
Total and Dissolved Metals							
Aluminum, Total	ug/L		531	419 - 597	40.6	33.1 - 46.2	92
Arsenic, Total	ug/L	P115	<2.41	ND(2.32) - 2.60	ND(2.32)	ND(2.32)	> 3.8
Barium, Total (e) (s)	ug/L		64.1	59.1 - 71.0	19.9	14.6 - 25.8	69
Boron, Total (s)	ug/L		68.1	59.0 - 77.9	ND(3.37)	ND(3.37)	> 95
Cadmium, Total	ug/L	P118	<0.449	ND(0.446) - 0.460	ND(0.446)	ND(0.446)	> 0.62
Calcium, Total (e) (s)	ug/L		20,200	13,300 - 23,200	12,000	7,240 - 14,200	41
Chromium, Total	ug/L	P119	<3.02	ND(1.68) - 4.00	ND(1.68)	ND(1.68)	> 44
Copper, Total (e) (s)	ug/L	P120	246	184 - 314	8.97	6.90 - 11.8	96
Iron, Total (e) (s)	ug/L		1,610	1,430 - 1,740	298	171 - 376	81
Lead, Total (e)	ug/L	P122	<7.18	ND(3.08) - 14.8	ND(3.08)	ND(3.08)	> 57
Magnesium, Total (s)	ug/L		4,290	3,500 - 4,940	2,040	1,490 - 2,460	52
Manganese, Total (e) (s)	ug/L		59.1	48.3 - 67.7	16.1	12.2 - 18.4	73
Mercury, Total (s)	ug/L	P123	<0.423	ND(0.0170) - 0.720	<0.168	ND(0.0170) - 0.320	60
Nickel, Total (s)	ug/L	P124	27.3	21.6 - 35.7	15.3	8.00 - 23.8	44
Selenium, Total	ug/L	P125	1.26	1.00 - 1.50	<0.781	<0.586 - 0.970	38
Silver, Total	ug/L	P126	<1.89	ND(1.28) - 3.90	ND(1.28)	ND(1.28)	> 33
Sodium, Total (e) (s)	ug/L		78,100	68,200 - 91,900	86,800	69,600 - 107,000	NC
Thallium, Total (s)	ug/L	P127	ND(0.00900)	ND(0.00900)	<0.00920	ND(0.00900) - 0.0100	NC

(a) Sampling point location; see Figure 2-2.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
NC - Percent removal not calculated because the effluent concentration was greater than the influent concentration, or the analyte was not detected in the influent sample.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Indicates a minimum level of removal.

Table 4-6 (Continued)

Analyte	Unit	Priority Pollutant Code	Average Influent to Treatment Concentration (SP-6) (a)	Influent to Treatment Concentration Range (SP-6) (a)	Average Effluent from Treatment Concentration (SP-9) (a)	Effluent from Treatment Concentration Range (SP-9) (a)	Percent Removal
Tin, Total	ug/L		<4.31	ND(3.45) - 6.80	ND(3.45)	ND(3.45)	> 20
Titanium, Total (e)	ug/L		2.52	1.90 - 3.40	ND(0.253)	ND(0.253)	> 90
Zinc, Total (e) (s)	ug/L	P128	947	719 - 1,300	360	162 - 562	62
Aluminum, Dissolved (e) (s)	ug/L		98.5	31.0 - 238	37.4	34.6 - 41.9	62
Barium, Dissolved (e) (s)	ug/L		20.4	14.5 - 34.1	19.7	14.5 - 25.8	3.6
Boron, Dissolved (s)	ug/L		67.7	62.3 - 72.8	<6.84	ND(3.37) - 20.7	90
Calcium, Dissolved (e) (s)	ug/L		13,400	9,600 - 17,500	11,800	7,090 - 14,000	11
Cobalt, Dissolved (s)	ug/L		3.48	2.10 - 4.20	<1.04	ND(0.914) - 1.50	70
Copper, Dissolved (e) (s)	ug/L	P120	59.0	34.4 - 136	8.00	5.60 - 11.0	86
Iron, Dissolved (e)	ug/L		574	395 - 921	285	152 - 357	50
Lead, Dissolved (e)	ug/L	P122	<3.08	ND(3.08) - 3.10	ND(3.08)	ND(3.08)	> 0.13
Magnesium, Dissolved (e) (s)	ug/L		3,370	2,780 - 3,900	2,020	1,460 - 2,440	40
Manganese, Dissolved (e) (s)	ug/L		22.9	17.2 - 37.6	17.3	13.4 - 19.4	24
Mercury, Dissolved (s)	ug/L	P123	0.360	0.320 - 0.420	0.324	0.270 - 0.390	10.0
Nickel, Dissolved (s)	ug/L	P124	22.7	16.0 - 33.3	15.5	8.40 - 23.5	32
Selenium, Dissolved	ug/L	P125	0.982	0.840 - 1.20	<0.746	<0.606 - 0.900	24
Sodium, Dissolved (e) (s)	ug/L		74,700	65,400 - 86,000	85,700	69,700 - 105,000	NC
Titanium, Dissolved (e)	ug/L		<0.314	ND(0.253) - 0.560	<0.274	ND(0.253) - <0.317	13
Vanadium, Dissolved	ug/L		ND(0.679)	ND(0.679)	<0.695	ND(0.679) - 0.760	NC
Zinc, Dissolved (e) (s)	ug/L	P128	318	111 - 634	353	164 - 553	NC

(a) Sampling point location; see Figure 2-2.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
NC - Percent removal not calculated because the effluent concentration was greater than the influent concentration, or the analyte was not detected in the influent sample.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Indicates a minimum level of removal.

Table 4-6 (Continued)

Analyte	Unit	Priority Pollutant Code	Average Influent to Treatment Concentration (SP-6) (a)	Influent to Treatment Concentration Range (SP-6) (a)	Average Effluent from Treatment Concentration (SP-9) (a)	Effluent from Treatment Concentration Range (SP-9) (a)	Percent Removal
Volatile and Semivolatile Organics							
Bis(2-ethylhexyl)phthalate	ug/L	P066	<15.9	ND(10.0) - 24.0	ND(10.0)	ND(10.0)	> 37
Phenol	ug/L	P065	<15.5	ND(10.0) - 25.1	ND(10.0)	ND(10.0)	> 35
Tetrachloroethene	ug/L	P085	993	147 - 2,740	33.4	10.4 - 47.7	97
Trichloroethene	ug/L	P087	40.3	20.1 - 66.9	ND(10.0)	ND(10.0)	> 75

(a) Sampling point location; see Figure 2-2.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
NC - Percent removal not calculated because the effluent concentration was greater than the influent concentration, or the analyte was not detected in the influent sample.
ND - Not detected (number in parentheses is detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).
> - Indicates a minimum level of removal.

Table 4-7

Treatment System Residuals and Incinerator Ash Analytical Results, Holland America Veendam

Analytical results for one-time grab samples of treatment system residuals (screening solids from two coarse screens and excess biological mass from bioreactors) and incinerator ash for analytes detected at least once in these samples. See Appendix A-2 for all analytical results (detected and nondetected). Figures 2-1 and 2-2 identify the sampling point locations; see Table 3-2 for sample collection methodology. Also shown are average concentrations for the influent to treatment samples (from Table 4-2) for comparison. Certain screening solids and waste biosludge results were converted from mass to volume units; see Section 3.3. Priority pollutants (designated by EPA in 40 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Priority Pollutant Code	Screening Solids (SP-11) (a)	Biosludge (SP-12) (a)	Incinerator Ash (SP-13) (a)	Average Influent to Treatment (SP-6) (a)
Classical Pollutants					
Alkalinity (s)		223 mg/L	499 mg/L	NC	363 mg/L
Ammonia as Nitrogen (NH3-N) (s)		21.6 mg/L	76.3 mg/L	NC	71.0 mg/L
Biochemical Oxygen Demand (BOD_5)		6,610 mg/L	3,870 mg/L	NC	577 mg/L
Chemical Oxygen Demand (COD)		12,300 mg/L	14,800 mg/L	NC	1,480 mg/L
Chloride (s)		137 mg/L	62.4 mg/L	NC	79.0 mg/L
Hardness (e) (s)		55.3 mg/L	49.2 mg/L	NC	68.0 mg/L
Settleable Residue		1,000 mL/L	560 mL/L	NC	55.8 mL/L
Sulfate (s)		90.2 mg/L	398 mg/L	NC	29.8 mg/L
Total Kjeldahl Nitrogen (TKN) (s)		470 mg/L	1,280 mg/L	NC	105 mg/L
Total Organic Carbon (TOC)		348 mg/L	75.5 mg/L	NC	198 mg/L
Total Phosphorus		75.9 mg/L	153 mg/L	NC	15.0 mg/L
Total Metals					
Aluminum, Total		19,200 ug/L	10,500 ug/L	44,800 mg/kg	531 ug/L
Antimony, Total	P114	25.8 ug/L	16.9 ug/L	28.3 mg/kg	ND(5.97) ug/L
Arsenic, Total	P115	ND(2.32) ug/L	7.60 ug/L	5.20 mg/kg	<2.41 ug/L

(a) Sampling point location; see Figures 2-1 and 2-2.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is the detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-7 (Continued)

Analyte	Priority Pollutant Code	Screening Solids (SP-11) (a)	Biosludge (SP-12) (a)	Incinerator Ash (SP-13) (a)	Average Influent to Treatment (SP-6) (a)
Barium, Total (e) (s)		1,950 ug/L	1,560 ug/L	837 mg/kg	64.1 ug/L
Beryllium, Total	P117	ND(0.0540) ug/L	ND(0.0540) ug/L	0.410 mg/kg	ND(0.0540) ug/L
Boron, Total (s)		286 ug/L	775 ug/L	585 mg/kg	68.1 ug/L
Cadmium, Total	P118	3.50 ug/L	5.20 ug/L	1.40 mg/kg	<0.449 ug/L
Calcium, Total (e) (s)		166,000 ug/L	132,000 ug/L	174,000 mg/kg	20,200 ug/L
Chromium, Total	P119	72.4 ug/L	64.1 ug/L	286 mg/kg	<3.02 ug/L
Cobalt, Total		9.30 ug/L	7.90 ug/L	13.7 mg/kg	ND(0.914) ug/L
Copper, Total (e) (s)	P120	2,180 ug/L	4,230 ug/L	6,510 mg/kg	246 ug/L
Iron, Total (e) (s)		59,600 ug/L	43,800 ug/L	28,500 mg/kg	1,610 ug/L
Lead, Total (e)	P122	40.6 ug/L	59.8 ug/L	417 mg/kg	<7.18 ug/L
Magnesium, Total (s)		33,600 ug/L	39,400 ug/L	13,600 mg/kg	4,290 ug/L
Manganese, Total (e) (s)		1,150 ug/L	980 ug/L	673 mg/kg	59.1 ug/L
Molybdenum, Total		26.5 ug/L	36.5 ug/L	42.8 mg/kg	ND(1.50) ug/L
Nickel, Total (s)	P124	160 ug/L	234 ug/L	223 mg/kg	27.3 ug/L
Selenium, Total	P125	16.7 ug/L	25.7 ug/L	1.39 mg/kg	1.26 ug/L
Silver, Total	P126	17.5 ug/L	30.1 ug/L	15.4 mg/kg	<1.89 ug/L
Sodium, Total (e) (s)		157,000 ug/L	142,000 ug/L	49,600 mg/kg	78,100 ug/L
Thallium, Total (s)	P127	0.0800 ug/L	ND(0.0450) ug/L	ND(1.53) mg/kg	ND(0.00900) ug/L
Tin, Total		76.9 ug/L	51.6 ug/L	61.6 mg/kg	<4.31 ug/L
Titanium, Total (e)		23.6 ug/L	7.10 ug/L	1,060 mg/kg	2.52 ug/L
Vanadium, Total		77.6 ug/L	21.8 ug/L	484 mg/kg	ND(0.679) ug/L
Yttrium, Total		ND(0.222) ug/L	ND(0.222) ug/L	3.10 mg/kg	ND(0.222) ug/L

(a) Sampling point location; see Figures 2-1 and 2-2.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is the detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-7 (Continued)

Analyte	Priority Pollutant Code	Screening Solids (SP-11) (a)	Biosludge (SP-12) (a)	Incinerator Ash (SP-13) (a)	Average Influent to Treatment (SP-6) (a)
Zinc, Total (e) (s)	P128	6,390 ug/L	5,930 ug/L	2,700 mg/kg	947 ug/L
Volatile and Semivolatile Organics					
Bis(2-ethylhexyl)phthalate	P066	91.6 ug/L	21.1 ug/L	2,260 ug/kg	<15.9 ug/L
Phenanthrene	P081	ND(28.8) ug/L	ND(13.5) ug/L	441 ug/kg	ND(10.0) ug/L
Phenol	P065	700 ug/L	875 ug/L	1,140 ug/kg	<15.5 ug/L
Tetrachloroethene	P085	1.66 ug/L	2.63 ug/L	NC	993 ug/L
Trichloroethene	P087	ND(0.283) ug/L	1.14 ug/L	NC	40.3 ug/L
Dioxins and Furans					
1,2,3,4,6,7,8-HpCDD		NC	NC	192 pg/g	NC
1,2,3,4,6,7,8-HpCDF		NC	NC	1,890 pg/g	NC
1,2,3,4,7,8,9-HpCDF		NC	NC	117 pg/g	NC
1,2,3,4,7,8-HxCDD		NC	NC	<11.8 pg/g	NC
1,2,3,4,7,8-HxCDF		NC	NC	188 pg/g	NC
1,2,3,6,7,8-HxCDD		NC	NC	17.5 pg/g	NC
1,2,3,6,7,8-HxCDF		NC	NC	187 pg/g	NC
1,2,3,7,8,9-HxCDD		NC	NC	29.2 pg/g	NC
1,2,3,7,8,9-HxCDF		NC	NC	<11.2 pg/g	NC
1,2,3,7,8-PeCDD		NC	NC	<8.2 pg/g	NC
1,2,3,7,8-PeCDF		NC	NC	42.4 pg/g	NC
2,3,4,6,7,8-HxCDF		NC	NC	426 pg/g	NC
2,3,4,7,8-PeCDF		NC	NC	130 pg/g	NC
2,3,7,8-TCDD		NC	NC	1.50 pg/g	NC

(a) Sampling point location; see Figures 2-1 and 2-2.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is the detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-7 (Continued)

Analyte	Priority Pollutant Code	Screening Solids (SP-11) (a)	Biosludge (SP-12) (a)	Incinerator Ash (SP-13) (a)	Average Influent to Treatment (SP-6) (a)
2,3,7,8-TCDF		NC	NC	35.2 pg/g	NC
Octachlorodibenzo-p-dioxin		NC	NC	427 pg/g	NC
Octachlorodibenzofuran		NC	NC	742 pg/g	NC

(a) Sampling point location; see Figures 2-1 and 2-2.
(e) Analyte detected at some level in the equipment blank. See Section 5.2.2 and Table 5-2 for equipment blank results.
(s) Analyte detected at some level in the source water. See Section 4.1.7 and Table 4-8 for source water results.
NC - Not collected.
ND - Not detected (number in parentheses is the detection limit).
< - Average result includes at least one nondetect value (calculation uses detection limits for nondetected results).

Table 4-8

Source Water Analytical Results, Holland America Veendam

Analytical results for one-time grab sample of source water for detected analytes. See Appendix A-2 for all analytical results (detected and nondetected). Also shown are Federal drinking water standards for comparison. Priority pollutants (designated by EPA in 30 CFR Part 423, Appendix A) are identified where applicable.

Analyte	Unit	Priority Pollutant Code	Source Water (SP-15) (a)	Federal Drinking Water Standards (b)
Classical Pollutants				
Alkalinity	mg/L		57.0	
Ammonia As Nitrogen (NH3-N)	mg/L		0.0570	
Chloride	mg/L		15.0	250
Hardness	mg/L		68.5	
Nitrate/Nitrite (NO2-N + NO3-N)	mg/L		0.270	10 (Nitrate) 1 (Nitrite)
Sulfate	mg/L		21.0	250
Total Dissolved Solids (TDS)	mg/L		121	500
Total Kjeldahl Nitrogen (TKN)	mg/L		1.00	
Total and Dissolved Metals				
Barium, Total	ug/L		32.0	2,000
Boron, Total	ug/L		33.0	
Calcium, Total	ug/L		24,200	
Copper, Total	ug/L	P120	72.2	1,300
Iron, Total	ug/L		30.6	300
Magnesium, Total	ug/L		1,950	
Manganese, Total	ug/L		0.720	50
Mercury, Total	ug/L	P123	0.310	2.0
Nickel, Total	ug/L	P124	15.8	
Sodium, Total	ug/L		10,500	
Thallium, Total	ug/L	P127	0.0200	2.0
Zinc, Total	ug/L	P128	13.6	5,000
Aluminum, Dissolved	ug/L		14.8	
Barium, Dissolved	ug/L		30.9	
Boron, Dissolved	ug/L		39.1	
Calcium, Dissolved	ug/L		24,300	
Cobalt, Dissolved	ug/L		1.70	
Copper, Dissolved	ug/L	P120	59.7	
Magnesium, Dissolved	ug/L		1,960	
Manganese, Dissolved	ug/L		2.60	
Mercury, Dissolved	ug/L	P123	0.420	
Nickel, Dissolved	ug/L	P124	14.5	
Sodium, Dissolved	ug/L		10,500	
Zinc, Dissolved	ug/L	P128	8.40	

(a) Sampling point number; see Table 2-1.
(b) 40 CFR 141.62 National Primary Maximum Contaminant Levels for Inorganic Contaminants (nitrate/nitrite, barium, mercury, thallium); 40 CFR 141.51 National Primary Maximum Contaminant Level Goals for Inorganic Contaminants (copper); and 40 CFR 143.3 Secondary Maximum Contaminant Levels (chloride, sulfate, TDS, iron, manganese, zinc).

Table 4-9

Laundry Cleaning Agents Used Onboard, Holland America Veendam

Chemical Name	Ingredients According to Material Safety Data Sheets
Diver Alik-Liquid alkali	10% to 30% NaOH 3% to 7% sodium nitrolotriacetate
Renew Extra-Liquid Laundry Detergent	10% to 30% linear alcohol ethoxylate 3% to 7% sodium dodecylbenzene sulfonate 3% to 7% ethylene glycol monobutyl ether
Super Impede-Stain Remover	Unknown (MSDS not provided)
Divercide 6F-Liquid Laundry Sour (silicofluorides mineral acid)	10% to 30% hydrofluorosilic acid
Valid II-Fabric Softener (cationic surfactant)	10% to 30% ditallow diamido methosulphate 1% to 5% isopropanol
Emphasize-Starch and Sizing Blend	Sodium chloride Water Polyvinylacetate emulsion Modified corn starch

Table 4-10

Flow Data by Sampling Period, Holland America Veendam

Flow data collected via strap-on ultrasonic flow meter for the laundry and via the Veendam's in-line flow meters for the influent to and effluent from the treatment system (see Section 4.3). Total daily flow data for the influent to treatment system were calculated from flow readings recorded from the Veendam's in-line flow meters installed on the graywater and sewage lines that feed into the treatment system. These sources added together equal the total flow into the treatment system. Figures 2-1 and 2-2 show the flow meter locations. Flow per capita was calculated by dividing the daily flow totals by the total number of passengers and crew (1,820 people) onboard the Veendam during the sampling episode.

	Laundry (SP-1)		Influent to Treatment System (SP-6)						Effluent from Treatment System (SP-9)	
Sampling Period	Strap-on Daily Total Flow, gal/day (m^3/day) (a)	Daily Flow Per Capita, gal/day/person (m^3/day/person)	In-line Sewage Daily Total Flow, gal/day (m^3/day) (b)	Sewage Daily Flow Per Capita, gal/day/person (m^3/day/person)	In-line Graywater Daily Total Flow, gal/day (m^3/day) (b)	Graywater Daily Flow Per Capita, gal/day/person (m^3/day/person)	In-line Daily Total Flow, gallons/day (m^3/day) (c)	Combined Sewage and Graywater Daily Flow Per Capita, gal/day/person (m^3/day/person)	In-line Daily Total Flow, gal/day (m^3/day) (b)	Daily Flow Per Capita, gal/day/person (m^3/day/person)
Day 1	26,700 (101)	14.7 (0.055)	31,100 (118)	17.1 (0.065)	82,300 (312)	45.2 (0.171)	113,000 (429)	62.3 (0.236)	109,000 (412)	59.8 (0.226)
Day 2	23,200 (88.0)	12.8 (0.048)	33,000 (125)	18.1 (0.069)	81,300 (308)	44.7 (0.169)	114,000 (432)	62.8 (0.238)	103,000 (388)	56.3 (0.213)
Day 3	26,700 (101)	14.7 (0.055)	31,700 (120)	17.4 (0.066)	81,800 (310)	45 (0.17)	114,000 (430)	62.4 (0.236)	50,000 (189) (d)	27.5 (0.104) (d)
Day 4	21,400 (81.0)	11.7 (0.045)	29,800 (113)	16.4 (0.062)	81,800 (310)	44.9 (0.17)	112,000 (422)	61.3 (0.232)	97,600 (370)	53.6 (0.203)
Day 5	20,600 (78.0)	11.3 (0.043)	31,200 (118)	17.2 (0.065)	79,000(299)	43.4 (0.164)	110,000 (417)	60.6 (0.229)	115,000 (435)	63.1 (0.239)
Average	23,800 (90.0)	13.1 (0.049)	31,400 (119)	17.2 (0.065)	81,200 (307)	44.6 (0.169)	113,000 (426)	61.9 (0.234)	106,000 (401) (d)	58.2 (0.220) (d)

(a) Flow data collected from strap-on flow meter installed by the sampling team.
(b) Flow data calculated from flow readings recorded from the Veendam's in-line flow meters; see Section 4.3.
(c) Influent to treatment flow was calculated by adding flow data collected from in-line flow meters installed on the graywater and sewage lines that feed into the treatment system.
(d) Average daily discharge flow rate for effluent from treatment system excludes data for Day 3 when the Veendam discontinued discharge while it cruised Glacier Bay National Park.

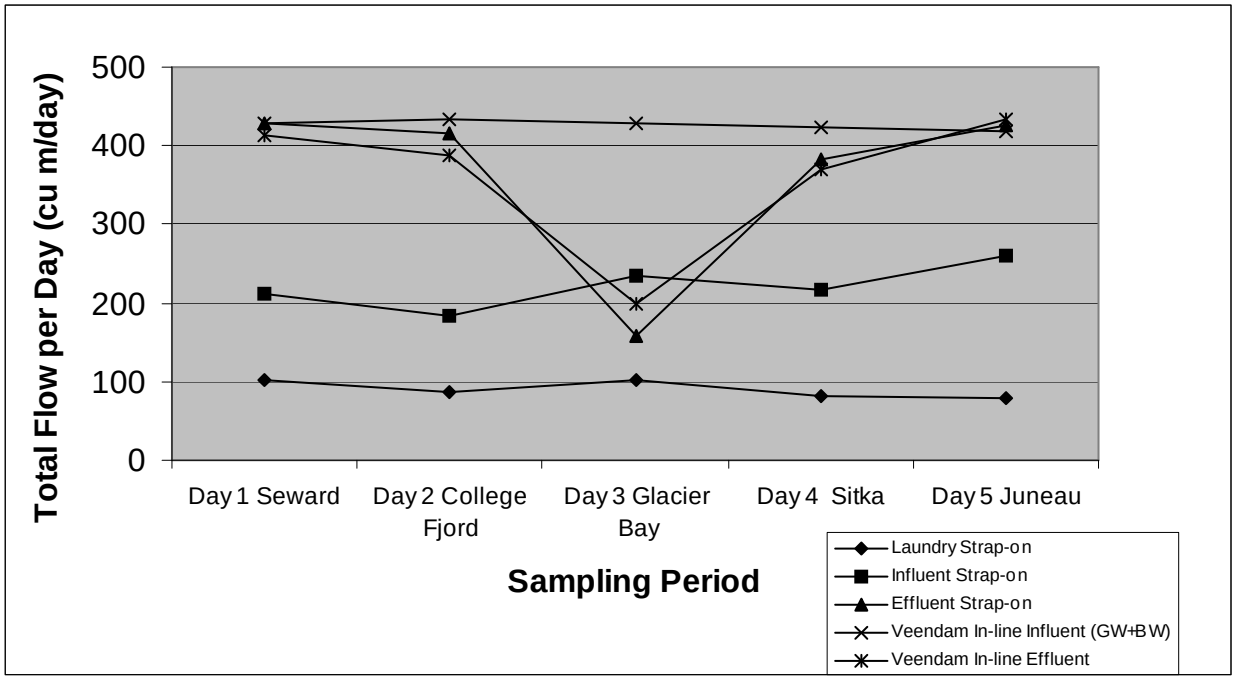

Figure 4-1. Total Daily Flow, Holland America Veendam

Flow data collected via strap-on ultrasonic flow meters installed by the sampling team and from the Veendam's in-line flow meters. Flow data are presented as daily totals calculated for each location. Combined, the in-line flow meters on the sewage and graywater tank discharges represent the flow into the treatment system. Figures 2-1 and 2-2 show the flow meter locations. Flow data recorded by the strap-on flow meter installed at the influent to treatment are suspect.

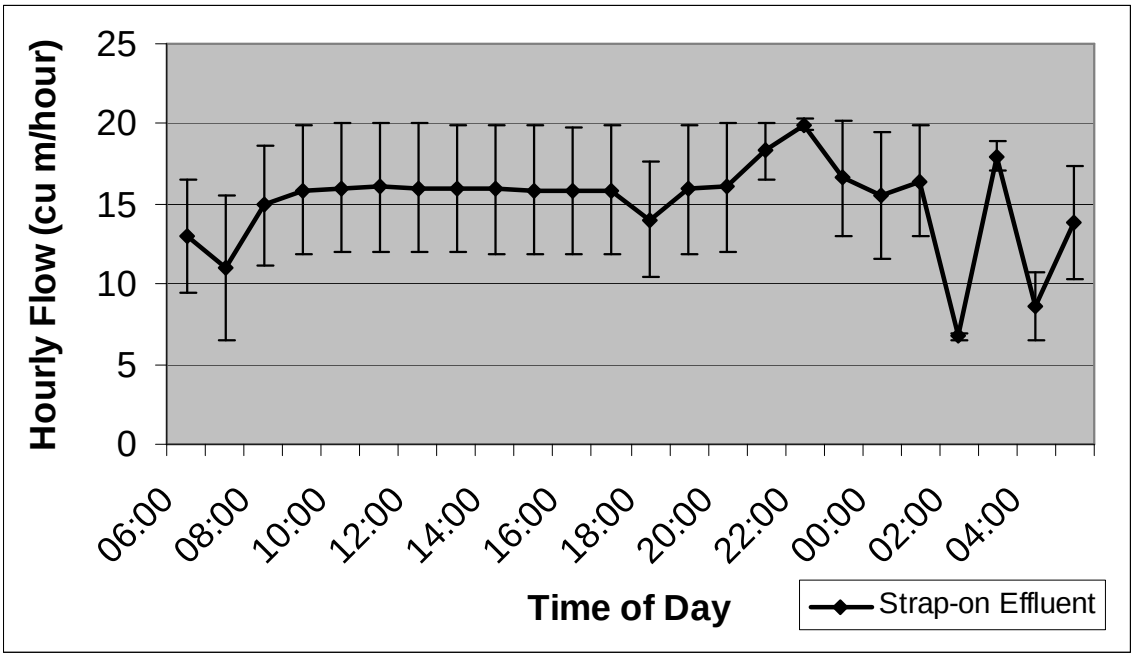

Figure 4-2. Average Hourly Wastewater Treatment System Flow, Holland America Veendam

Average effluent flow for each hour interval over the five consecutive 24-hour sampling periods, calculated and plotted from the strap-on flow meter installed by the sampling team. Figure 2-2 shows the flow meter location. Bars represent the standard deviation of the hourly flow calculated for the five consecutive sampling days.